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Notice of Allowability	Application No.	Applicant(s)	
	09/540,524	TAMEZ-PENA ET AL.	
	Examiner	Art Unit	
	Tiffany A Fetzner	2859	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 10/05/2004 & the telephonic interview of 01/07/2005.

2. ☒ The allowed claim(s) is/are 1,2,4,6-9,12,13,28,29,31,33-36,39 and 40.

3. ☒ The drawings filed on 05 October 2004 are accepted by the Examiner.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some* c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.

(a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached

1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.

(b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)

2. ☒ Notice of Draftperson's Patent Drawing Review (PTO-948)

3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____

4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material

5. ☐ Notice of Informal Patent Application (PTO-152)

6. ☒ Interview Summary (PTO-413), Paper No./Mail Date 01/07/2005.

7. ☒ Examiner's Amendment/Comment

8. ☒ Examiner's Statement of Reasons for Allowance

9. ☐ Other _____.

Examiner's Amendment

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it **MUST** be submitted no later than the payment of the issue fee.
2. Authorization for this examiner's amendment was given in a telephone interview with **Attorney David Edmundson Reg. No. 35,126** on January 7th 2005 along with authorization to charge any necessary fees to applicant's deposit account.
3. The application has been amended as follows:

A) Replace claim 1 with the following Examiner amended claim 1:

Claim 1 --- A method of forming an isotropic, high-resolution, three-dimensional diagnostic image of a subject from two-dimensional image data, the method comprising:

(a) scanning the subject with an imaging scanner device, in a first direction relative to the subject, in order to take image data of a first plurality of slices, the image data of the first plurality of slices being two-dimensional image data and having a low resolution in the first direction and a high resolution in directions orthogonal to the first direction;

(b) scanning the subject with said imaging scanner device in a second direction relative to the subject, which is different from the first direction in order to take image data of a second plurality of slices, the image data of the second plurality of slices being two-dimensional image data having at least one dimension substantially in common with the image data of the first plurality of slices and having a low resolution in the second direction and a high resolution in directions orthogonal to the second direction;

(c) registering the first plurality of slices with the second plurality of slices to define a matrix of isotropic, high-resolution voxels in image space, wherein the matrix has unknown high-resolution voxel values; and

(d) solving for the unknown high-resolution voxel values in the matrix defined in step (c) in accordance with the image data taken in steps (a) and (b) in order to form the isotropic high-resolution three-dimensional diagnostic image in the image space. ---

B) Cancel claim 3

C) Replace claim 4 with the following Examiner amended claim 4:

Claim 4 --- The method of **claim 1**, wherein step (c) comprises maximizing a correlation based on the directionally scanned image data of the first and second pluralities of slices. ---

D) Cancel claim 5

E) Replace claim 6 with the following Examiner amended claim 6:

Claim 6 --- The method of **claim 4**, wherein the correlation is maximized through a hill-climbing technique in which successively larger values of the correlation are located until a local maximum value of the correlation is reached. ---

F) Replace claim 8 with the following Examiner amended claim 8:

Claim 8 --- The method of **claim 7**, wherein: steps (a) and (b) are performed with an imaging scanner device having an in-plane resolution; and the multiresolution hill-climbing technique is performed with a plurality of resolutions including:

- (i) a maximum resolution which is twice the in-plane resolution; and
- (ii) a minimum resolution which is one-quarter of the in-plane resolution.

- G) Cancel claim 10
- H) Cancel claim 11
- I) Cancel claims 14 through 27.
- J) Replace claim 28 with the following **Examiner amended claim 28**:

Claim 28 --- A system forming an isotropic, high-resolution, three-dimensional diagnostic image of a subject from two-dimensional image data, the system comprising:
scanning means for

(i) scanning the subject in a first direction relative to the subject in order to take image data of a first plurality of slices, the image data of the first plurality of slices being two-dimensional image data and having a low resolution in the first direction and a high resolution in directions orthogonal to the first direction, and

(ii) scanning the subject in a second direction relative to the subject which is different from the first direction in order to take image data of a second plurality of slices, the image data of the second plurality of slices being two-dimensional image data having at least one dimension substantially in common with the image data of the first plurality of slices and having a low resolution in the second direction and a high resolution in directions orthogonal to the second direction;
and

computing means for

(i) registering the first plurality of slices with the second plurality of slices in order to define a matrix of isotropic, high-resolution voxels in image space, wherein the matrix has unknown high-resolution voxel values and

(ii) solving for the unknown high-resolution voxel values in the matrix defined by the computing means in accordance with the image data taken in the first and second directions by the scanning means and thereby form the isotropic, high-resolution, three-dimensional, diagnostic image in the image space. ---

K) Cancel claim 30

L) Replace claim 31 with the following Examiner amended claim 31:

Claim 31 --- The system of **claim 28**, wherein the computing means registers the first and second pluralities of slices by maximizing a directionally scanned correlation based on the image data of the first and second pluralities of slices. ---

M) Cancel claim 32

N) Replace claim 33 with the following Examiner amended claim 33:

Claim 33 --- The system of claim 31, wherein the directionally scanned correlation is maximized through a hill-climbing technique in which successively larger values of the correlation are located until a local maximum value of the correlation is reached. ---

O) Cancel claim 37.

P) Cancel claim 38.

Q) Cancel claims 41 through 54.

R) Replace the current title with:

--- A method and system which forms an isotropic, high-resolution, three-dimensional diagnostic image of a subject from two-dimensional image data scans. ---

Examiner's Comment

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

Drawings

5. The Official draftsperson has **accepted** applicant's submitted Formal drawings of October 5th 2005. See the attached PTO 948 Official Draftsperson's Review Form, of January 7th 2005 which accompanies this office action.

6. The examiner also accepts the drawings submitted October 5th 2004.

Canceled Claims

7. As per the examiner's Amendment of this office action, which has been authorized by the applicant's representative **Claims 5, 10, 32 and 37 are canceled**. Additionally **claims 11 and 38** were canceled without prejudice from the July 25th 2002 amendment and response.

8. **Withdrawn Claims 3, 14-27, 30, and 41-54** from the October 5th 2004 amendment and response have also been **canceled** as per the examiner's amendment above in order to place the application in condition for allowance. The applicant's attorney indicated that a divisional application for the withdrawn claims would be filed.

Pending Claims

9. The pending claims are **claims 1, 2, 4, 6-9, 12-13, 28, 29, 31, 33-36, and 39-40**.

Response to Arguments

10. Applicant's arguments from the Amendment Response filed 10/05/2004 with respect to pending **claims 1, 2, 4, 6-9, 12-13, 28, 29, 31, 33-36, and 39-40**, have been considered and are persuasive in view of the October 5th 2004 amendments to

independent claims 1 and 28; and the above examiner's amendment authorized by the attorney in the telephonic interview of January 7th 2004.

Claim Rejections - 35 USC § 112

11. The objections under 35 USC 112 from the May 18th 2004 office action have been **rescinded** in view of the October 5th 2004 amendments to **amended claims 1, 6, 28, and 33**, which successfully addresses and resolves the issues of the previous office action without adding new matter. The **amendments to claims 1 and 28** from the October 5th 2004 amendment are supported by original specification figure 4. The amendments to **claims 6 and 33** from the October 5th 2004 amendment are supported by original specification page 9 the second main paragraph.

The following is an examiner's statement of **Reasons for Allowance**:

12. With respect to **Examiner Amended Claim 1, and corresponding system claim 28**, these claims are allowable over the prior art of record because the prior art of record does not disclose or suggest a method / system comprising **forming an isotropic, high-resolution, three-dimensional diagnostic image of a subject from two-dimensional image data**, the method comprising: (a) scanning the subject with an imaging scanner device, in a first direction relative to the subject, in order to take image data of a first plurality of slices, the image data of **the first plurality of slices being two-dimensional image data and having a low resolution in the first direction and a high resolution in directions orthogonal to the first direction**; (b) scanning the subject with said imaging scanner device in a second direction relative to the subject, which is different from the first direction in order to take image data of a second plurality of slices, **the image data of the second plurality of slices being two-dimensional image data having at least one dimension substantially in common with the image data of the first plurality of slices and having a low resolution in the second direction and a high resolution in directions orthogonal to the second direction**; (c) registering the first plurality of slices with the second plurality of slices to define a matrix of isotropic, high-resolution voxels in image space, wherein the matrix has unknown high-resolution voxel values; and (d) solving for

the unknown high-resolution voxel values in the matrix defined in step (c) in accordance with the image data taken in steps (a) and (b) in order to form the isotropic high-resolution three-dimensional diagnostic image in the image space," in combination with the remaining limitations of each of the claims. It is the combination of the claim limitations taken as a whole that constitutes both the novelty and non-obviousness of applicant's claims.

13. The examiner also notes that It would not have been obvious to one of ordinary skill in the art at the time that the invention was made to construct an **isotropic matrix of three-dimensional high-resolution isotropic voxels of unknown high-resolution value** from two dimensional image data registered from two directionally different pluralities or image slices. Because conventionally two-dimensional data from different scans, at different times, in different directions produces only two-dimensionally resolved isotropic voxels. (i.e. there is blurring in the third dimension). Three-dimensional isotropic voxels are conventionally acquired from image data that is three-dimensional to start with. It is the combination of steps taken as a whole as well as the use of two-dimensional image data to produce a diagnostic image with isotropic high-resolution three-dimensional voxels that is novel over the prior art of record.

14. With respect to **claims 2, 4, 6-9, 12 and 13** these claims are allowable over the prior art of record because they depend from allowable **independent examiner amended claim 1**.

15. With respect to **claims 29, 31, 33-36, 39 and 40** these claims are allowable over the prior art of record because they depend from allowable **independent examiner amended claim 28**.

16. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "**Comments on Statement of Reasons for Allowance.**"

Prior Art of Record

17. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- A) **Stark et al.**, US patent 5,568,400 issued October 22nd 1996
- B) **Freundlich et al.**, US patent 6,178,220 B1 issued January 23rd 2001; with a 102 (e) date of October 18th 1999.
- C) **Catherine Westbrook and Carolyn Kaut** textbook "MRI in Practice SECOND EDITION" Blackwell Science, Inc., pages 47-57 and pages 101-103 1998.
- D) **Bushberg et al.**, textbook "The Essential Physics of Medical Imaging" Williams and Wilkins Philadelphia pages 325-327; 332-333; 336-339 1994.
- E) **Freundlich et al.**, PCT publication WO 98/24063 published 4 June 1998.
- F) **Mellin, A.F. et al**, "Three dimensional magnetic resonance microangiography of rat neurovasculature" magnetic resonance in medicine vol. 32, no.2 pages 199-205 1994. This reference teaches isotropic voxels of 59 μ m resolution obtained from a FOV with dimensional directions of 15 x 30 x 30 mm., and a matrix size of 256 x 256 x 512. [See page 200 col. 1 paragraph 2, therefore using different resolutions to achieve isotropic voxels was known by **Mellin**, in 1994] However this reference fails to teach limitations (c) or (d) of examiner amended independent claims 1 and 28 because unknown high-resolution voxels of an isotropic matrix are not solved for and then used to form a diagnostic high-resolution, three-dimensional image in the image space.
- G) **Henson M-M; et al.**, "Imaging the cochlea by magnetic resonance microscopy" Hearing research (NETHERLANDS) May 1994, 75 (1-2) pages 75-80, ISSN 0378-5955
- H) **Maier et al.**, US patent 5,786,692 issued July 28th 1998.
- I) **Higashi M** article "FASE (fast advanced spin echo) Nippon rinsho. Japanese journal of clinical medicine (JAPAN) Nov 1998, 56 (11) p2783-91, ISSN 0047-1852.
- J) **Mugler, III et al.**, US patent 5,245,282 issued September 14th 1993. This reference fails to teach obtaining isotropic, three-dimensional high-resolution voxels from image data that is originally two-dimensional.
- K) **Mori** US patent 6,526,305 B1 issued February 23rd 2003 filed November 19th 1999.
- L) **McKinnon** US patent 6,239,597 B1 issued May 29th 2001, filed October 14th 1999.

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M) Ning US patent 6,480,565 B1 issued November 12th 2002, filed August 18th 2000.

N) Mistretta US patent application publication US 2003/0135103 A1 published July 17th 2003, with an effective date of November 12th 2001. The examiner notes that this reference is not available as prior art against the claims of the instant application because applicant's filing date of the instant application is March 31st 2000. The Mistretta reference is noted only for the purposes of a complete record.

Conclusion

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tiffany Fetzner whose telephone number is: (571) 272-2241. The examiner can normally be reached on Monday-Thursday from 7:00am to 4:30pm., and on alternate Friday's from 7:00am to 3:30pm.

19. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego Gutierrez, can be reached at (571) 272-2245. The **only official fax phone number** for the organization where this application or proceeding is assigned is (703) 872-9306.



TAF
January 7, 2005



Diego Gutierrez
Supervisory Patent Examiner
Technology Center 2800